Image Shape Analysis

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Image Shape Analysis (ISA) is a software package written in the language C that accepts as input a gray-scale image, extracts objects from the image, and characterizes those objects. This process consists of these steps:

1. A gray-scale range is selected and pixels whose values fall in this range are marked as "active."
2. Connected contours are placed around connected sets of "active" pixels. The interiors of the contours are defined to be objects, and these objects are triangulated using a constrained Delaunay algorithm [1].
3. Statistics are gathered related to the objects' shapes, orientation, and structure.
4. A skeleton is constructed for each object.

Combining the following measured statistics can be used to determine if an object meets the decision criteria:

1. the area of the object,
2. the length of the perimeter of the object,
3. coordinates of the center of mass of the object,
4. the ratio of $radius_{area}$ to $radius_{perimeter}$ $(2*\pi*sqrt(area/\pi)/perimeter)$,
5. the ratio of the area of the junction triangle to the area of the object,
6. the area of the minimum enclosing rectangle (MER),
7. the angle of inclination of the minimum enclosing rectangle from the x-axis,
8. the length and width of the MER, and
9. the aspect ratio (width/length) of the MER.

One application of ISA is to qualify plumes [2]. The ideal plume is a teardrop-shaped object with irregular edges. When triangulated, this type of object will have many interior (junction) triangles, and Measure 5 will be relatively large. Conversely long, thin, straight objects will have few interior triangles, and Measure 5 will be relatively small. These long, thin, straight objects will also be identified by a small aspect ratio of the minimum-enclosing rectangle, Measure 9. The most difficult shapes to characterize are thin and curvy or straight-sided fat rectangles.

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[1] B.R. Schlei, "A New Computational Framework for 2D Shape-enclosing Contours," Los Alamos National Laboratory report LA-UR-04-3115 (May 2004).
[2] D.C. George, "Image Shape Analysis for Plume Characterization," Los Alamos National Laboratory report LA-UR-05-7082 (August 2005).

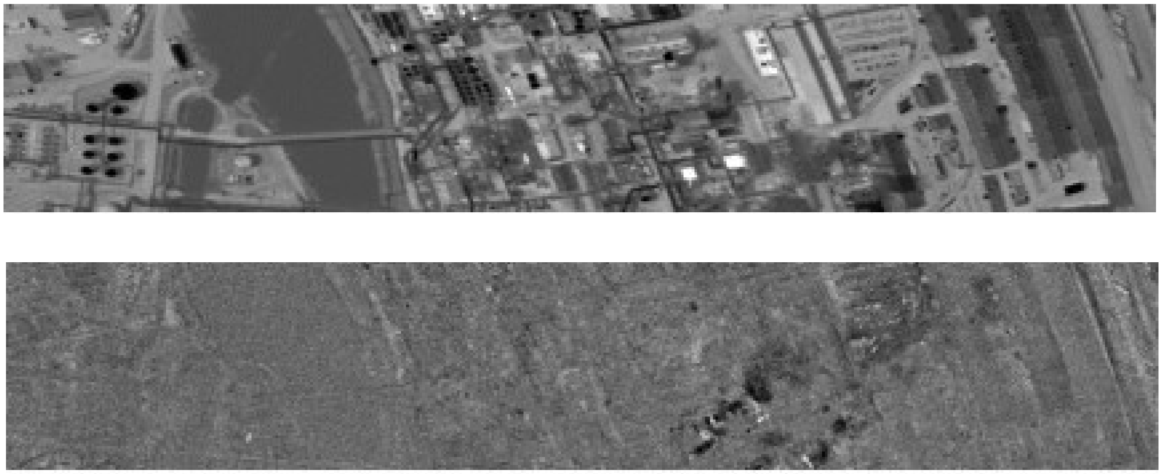

Fig. 1.
Broadband (top) and match filter (bottom) images of the same scene. In the match filter image there are two large plumes originating at the bottom, right of center.

Fig. 2.
ISA identifies these 22 objects when asked to select objects in the match filter image. The gray-scale pixel selection was set to choose both very dark and very light pixels. ISA was told to ignore small objects, those whose perimeters were less than 30 pixels long. The three objects on the far right are not plumes but are structures visible in the broadband image. ISA did not identify any objects in the left half of the image. Combining the two measurements of Triangle Ratio and MER Aspect Ratio, ISA correctly classifies all but three of the objects.